CLAIMS

What is claimed is:

1. A method for allocating bandwidth in a satellite communication system, the method comprising:

determining an uplink assignment of uplinks to user terminals and a gateway, based on a gateway uplink efficiency, a user terminal uplink efficiency, and a traffic ratio between the user terminal and the gateway; and

determining a downlink assignment of downlinks to the user terminals and the gateway, based on traffic offered to the user terminals and the gateway according to the uplink assignment.

2. A method according to claim 1, further comprising the step of communicating the uplink assignment and the downlink assignment to the user terminals and the gateway.

3. A method according to claim 2, wherein the step of communicating comprises communicating over a signaling channel supported by a satellite.

4. A method according to claim 1, wherein the step of determining an uplink assignment further comprises determining a non-integer uplink assignment based on subchannels forming an uplink.

5. A method according to claim 1, wherein the step of determining a downlink assignment further comprises determining a non-integer downlink assignment based on subchannels forming a downlink.

6. A method according to claim 1, wherein the step of determining an uplink assignment further comprises determining an integer uplink assignment by evaluating integer assignments of uplinks around a non-integer assignment of uplinks yielding maximum outbound capacity.

7. A method according to claim 6, wherein the step of determining an uplink assignment selects the maximum of:

$CarriedUp(AssignA_{gwul}, AssignA_{uul}) = minimum(AssignA_{gwul} * UE_{gwul}, R * AssignA_{uul} * UE_{uul})$ and

$CarriedUp(AssignB_{gwul}, AssignB_{uul}) = minimum(AssignB_{gwul} * UE_{gwul}, R * AssignB_{uul} * UE_{uul})$,

in accordance with:

$TentAssign_{gwul} = Num_{up} / 1 + SUUB)$,

$SUUB = (UE_{gwul} / UE_{uul}) / R$,

$TentAssign_{uul} = Num_{up} - TentAssign_{gwul}$,

$AssignA_{gwul} = ceiling(TentAssign_{gwul})$,

$AssignA_{uul} = floor(TentAssign_{uul})$,

$AssignB_{gwul} = floor(TentAssign_{gwul})$,

$AssignB_{uul} = ceiling(TentAssign_{uul})$,

where $TentAssign_{gwul}$ is a tentative assignment of uplinks to the gateway, Num_{up} is a total number of communication system uplinks, SUUB is a specific user bandwidth, $TentAssign_{uul}$ is a tentative assignment of uplinks to the user terminals, R is an outbound to inbound traffic ratio, UE_{gwul} is a utilization efficiency of a gateway uplink, and UE_{uul} is a utilization efficiency of a user terminal uplink.

8. A method according to claim 5, wherein the step of determining an uplink assignment comprises determining:

$Assign_{gwul} = Num_{up} / (1 + SUUB)$,

$SUUB = (UE_{gwul} / UE_{uul}) / R$, and

$Assign_{uul} = Num_{up} - TentAssign_{gwul}$.

where $Assign_{gwul}$ is an assignment of uplinks to the gateways, Num_{up} is a total number of communication system uplinks, SUUB is a specific user bandwidth, $TentAssign_{uul}$ is an assignment of uplinks to the user terminals, R is an outbound to inbound traffic ratio, UE_{gwul} is a utilization efficiency of a gateway uplink, and UE_{uul} is a utilization efficiency of a user terminal uplink.

9. A method according to claim 1, wherein the step of determining a downlink assignment further comprises determining a downlink assignment based further on a relative capacity of uplinks compared to downlinks.

10. A method according to claim 9, wherein the step of determining a downlink assignment comprises determining:

$Need_{gwdl} = RelSize * TO_{gwdl} / UE_{gwdl}$, and

$Need_{udl} = RelSize * TO_{udl} / UE_{udl}$,

where $Need_{gwdl}$ is a number of downlinks desired for each gateway and $Need_{udl}$ is a number of downlinks desired for the user terminals, RelSize is a relative size of uplinks compared with downlinks, TO_{gwdl} is traffic offered to the gateway downlinks, TO_{udl} is traffic offered to the user terminal downlinks, UE_{gwdl} is a utilization efficiency of a gateway downlink, and UE_{udl} is a utilization efficiency of a user terminal downlink.

11. A method according to claim 1, further comprising the step of determining when the downlink assignment requires assigning more than a total number of available downlinks, and in response, evaluating assignments of downlinks to the user terminals and the gateways to find a capacity maximizing downlink assignment given the total number of available downlinks.

12. A method according to claim 11, wherein the step of evaluating assignments comprises selecting a new assignment of downlinks for evaluation, determining

amounts of traffic offered to the gateway and the user terminals that fill the new assignment of downlinks, determining numbers of uplinks that provide the traffic offered, and determining traffic carried for the new assignment.

13. A method according to claim 12, further comprising the step of evaluating the numbers of uplinks that provide the traffic offered to account for concentration by a satellite.

14. A method according to claim 12, further comprising the step of compensating the amounts of traffic offered that fill the new assignment of downlinks to account for concentration by a satellite.

15. A method according to claim 12, wherein the step of determining traffic carried comprises evaluating:

$$TC = \text{minimum}(EUL_{gw} * UE_{gwul}, R * EUL_{u} * UE_{uul}),$$

where TC is traffic carried, R is an outbound to inbound traffic ratio, EUL_{gw} is a number of gateway uplinks that provide the traffic offered to the gateway, EUL_{u} is a number of user terminal uplinks that provide the traffic offered to the user terminals, UE_{gwdl} is a utilization efficiency of a gateway downlink, and UE_{udl} is a utilization efficiency of a user terminal downlink.

16. A satellite communication system bandwidth controller comprising:

assignment circuitry operable to determine at least one of an uplink assignment of uplinks to user terminals and a gateway, based on a gateway uplink efficiency, a

user terminal uplink efficiency, and a traffic ratio between the user terminal and the gateway and a downlink assignment of downlinks to the user terminals and the gateway, based on traffic offered to the user terminals and the gateway according to the uplink assignment; and

communication circuitry for communicating the uplink assignment and the downlink assignment to the user terminals and the gateway.

17. A satellite communication system bandwidth controller according to claim 16, further comprising input parameter determination circuitry for determining the gateway uplink efficiency, the user terminal uplink efficiency, and the traffic ratio.

18. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry and the communication circuitry are disposed onboard a satellite.

19. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry and the communication circuitry operate to evaluate a communication system in operation and to respond dynamically to adjust the uplink and downlink assignments.

20. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry operates to evaluate uplink and downlink assignments for a planned communication system.

21. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry is operable to determine a non-integer uplink assignment based on subchannels forming an uplink.

22. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry is operable to determine a non-integer downlink assignment based on subchannels forming a downlink.

23. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry is operable to determine an integer uplink assignment by evaluating integer assignments of uplinks around a non-integer assignment of uplinks yielding maximum outbound capacity.

24. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry is operable to determine when the downlink assignment requires assigning more than a total number of available downlinks, and in response, to evaluate assignments of downlinks to the user terminals and the gateway to find an optimized downlink assignment given the total number of available downlinks.

25. A satellite communication system bandwidth controller according to claim 24, wherein the assignment circuitry is further operable to select a new assignment of downlinks for evaluation, determine amounts of traffic offered to the gateway and the user terminals that fill the new assignment of downlinks, determine numbers of uplinks that provide the traffic offered, and determine traffic carried for the new assignment.

26. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry is further operable to compensate the numbers of uplinks that provide the traffic offered to account for concentration by a satellite.

27. A satellite communication system bandwidth controller according to claim 16, wherein the assignment circuitry is further operable to compensate for the amounts of traffic offered that fill the new assignment of downlinks to account for concentration by a satellite.

28. A satellite communication system comprising:

user terminals;

a gateway;

a satellite providing uplinks and downlinks for the user terminals and the gateway; and

a bandwidth controller comprising uplink and downlink assignment circuitry operable to determine an uplink assignment of the uplinks to user terminals and a gateway, based on a gateway uplink efficiency, a user terminal uplink efficiency, and a traffic ratio between the user terminals and the gateway and that is operable to determine a downlink assignment of the downlinks to the user terminals and the gateway, based on traffic offered to the user terminals and the gateway according to the uplink assignment.

29. A satellite communication system according to claim 28, wherein the bandwidth controller further comprises communication circuitry for communicating the uplink assignment and the downlink assignment to the user terminals and the gateway.

30. A satellite communication system according to claim 28, further comprising input parameter determination circuitry for determining the gateway uplink efficiency, user terminal uplink efficiency, and the traffic ratio by at least one of evaluating monitor input and receiving the gateway uplink efficiency, user terminal uplink efficiency, and the traffic ratio as design inputs.

31. A satellite communication system according to claim 28, wherein the bandwidth controller is disposed onboard the satellite.

32. A satellite communication system according to claim 28, wherein the bandwidth controller evaluates the satellite communication system periodically during operation and responds dynamically to adjust the uplink and downlink assignments.

33. A satellite communication system according to claim 28, wherein the uplinks are divisible into subchannels, and wherein the bandwidth controller determines non-integer uplink assignments based on the subchannels.

34. A satellite communication system according to claim 28, wherein the downlinks are divisible into subchannels and wherein the bandwidth controller determines non-integer downlink assignments based on the subchannels.

35. A satellite communication system according to claim 28, wherein the bandwidth controller determines integer uplink assignments by evaluating integer assignments of uplinks around a non-integer assignment of uplinks yielding maximum outbound capacity.

36. A satellite communication system according to claim 28, wherein the bandwidth controller determines when the downlink assignment requires assigning more than a total number of available downlinks, and in response, evaluates assignments of downlinks to the user terminals and the gateways to find an optimized downlink assignment given the total number of available downlinks.

37. A satellite communication system according to claim 28, wherein the satellite further comprises a concentrator, and wherein the bandwidth controller determines the downlink assignment in accordance with at least one of a user terminal downlink efficiency and a gateway downlink efficiency imposed by the concentrator.